

# MT THERM™ BORON NITRIDE FILLERS

THERMAL MANAGEMENT FOR ELECTRIC VEHICLE APPLICATIONS

POWER ELECTRONICS  
CONTROLLER

INVERTERS AND  
CONVERTERS

ELECTRIC TRACTION  
MOTOR

THERMAL SYSTEMS  
(COOLING)

CHARGE  
PORT

TRACTION  
BATTERY PACK

ONBOARD  
CHARGER

BATTERY  
(AUXILLARY)

TRANSMISSION

MOMENTIVE®  
TECHNOLOGIES



## THERMAL MANAGEMENT FOR ELECTRIC VEHICLES

Thermal management plays a vital role in maximizing the safety, performance, efficiency and overall longevity of electric vehicles (EV). Multiple components in EVs, such as power electronics, e-motors, and batteries require adequate thermal management as the industry is pushing for higher power, higher voltage, faster data transmission, lighter weight, and smaller size. Thermally conductive, but electrically insulating thermal interface materials (TIMs) with high dielectric strength and low dielectric constant are needed to meet these thermal management challenges. Since TIMs made of dielectric polymers are naturally thermally insulative, ceramic fillers need to be added to improve thermal conductivity while maintaining electrical resistance. Superior thermal and dielectric properties of the ceramic thermal fillers are key to the success of thermal management materials.

## CERAMIC THERMAL FILLER PROPERTIES

TYPICAL PROPERTIES	BN	AlN	Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	ZnO
Thermal Conductivity (W/m-K)	300*	260	30	1.4	54
Specific Heat (J/kg-K @ 25°C)	800	730	800	690	520
Theoretical Density (g/cc)	2.2	3.2	4.0	2.2	5.6
Dielectric Constant	3.9	8.8	9.7	3.8	9.9
Volume Resistivity (ohm-cm)	10 <sup>15</sup>	10 <sup>14</sup>	10 <sup>14</sup>	10 <sup>14</sup>	10 <sup>7</sup>
Coefficient of Thermal Expansion (ppm/K)	<1	4.4	6.7	<1	<1
Mohs Hardness	2	7	9	6	5

\* Thermal conductivity in crystal plane

## ADVANTAGES OF BN FILLERS

- **HIGH THERMAL CONDUCTIVITY**
- **HIGH BREAKDOWN VOLTAGE**
- **LOW DIELECTRIC CONSTANT**
- **LIGHT WEIGHT**
- **MECHANICAL COMPLIANCE**
- **THERMALLY STABLE**
- **CHEMICALLY INERT**
- **WHITE COLOR**

## BORON NITRIDE MEETS THE CHALLENGE

Thermal interface materials loaded with hexagonal **Boron Nitride** (BN) meet the challenges of offering high thermal conductivity (TC), high dielectric breakdown strength (DBS), low dielectric constant (Dk), low coefficient of thermal expansion (CTE), and low density to EV systems.

## APPLICATIONS IN ELECTRIC VEHICLES

- **TIMs FOR POWER ELECTRONIC COMPONENTS SUCH AS INVERTERS/CONVERTERS**
- **PCB LAMINATES FOR EV ELECTRONICS**
- **THERMAL MANAGEMENT MATERIALS FOR E-MOTORS**
- **TIMs FOR BATTERY ASSEMBLIES**

HIGH THERMAL CONDUCTIVITY

Boron Nitride has one of the highest thermal conductivities and electrical insulative properties of ceramic fillers. This, along with low dielectric loss characteristics, makes BN a highly desired filler in epoxies, silicones, and PU systems. Compared to other ceramic fillers such as spherical alumina, BN enables superior thermal and electrical performance, capable of providing more than 2x thermal conductivity and improved electrical breakdown properties. This is achieved with less volume loading compared to other fillers, and less impact to mechanical properties such as hardness. Higher thermal conductivities enable higher power through the circuits.

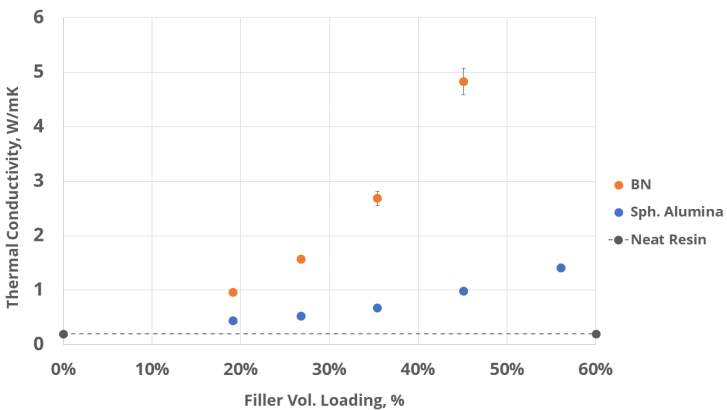
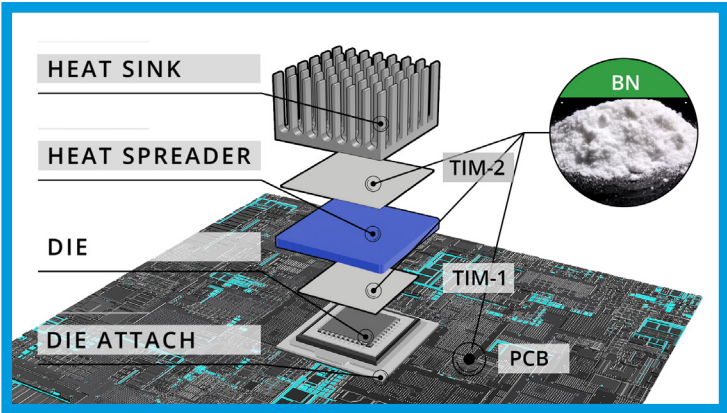


CHART 1: Thermal conductivity measured in silicone resin system, via HotDisk® method. Performances in other resin systems would be similar.

The inherent softness of BN as a filler ensures good contact between the component, heat sink and the TIM thereby minimizing contact resistances.



HIGH DIELECTRIC BREAKDOWN STRENGTH

For package and board level thermal management, higher thermal conductivities coupled with thinner bond lines of the dielectric layers enables lower thermal resistance. With increasing voltages in power electronics such as in EVs, maximizing electrical isolation in these thin dielectric layers becomes crucial. BN has one of the highest breakdown strengths (Eb) among fillers, enabling lower bond line thicknesses compared to others. The breakdown strength of BN filled system compares favorably with spherical alumina filled system at equivalent volume loadings.

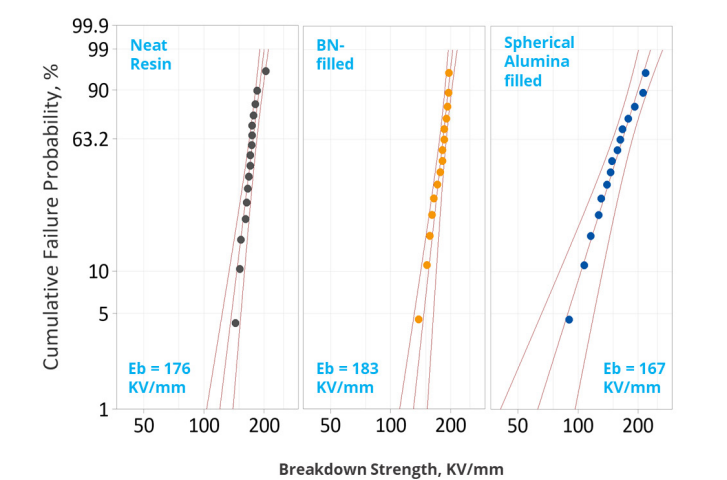
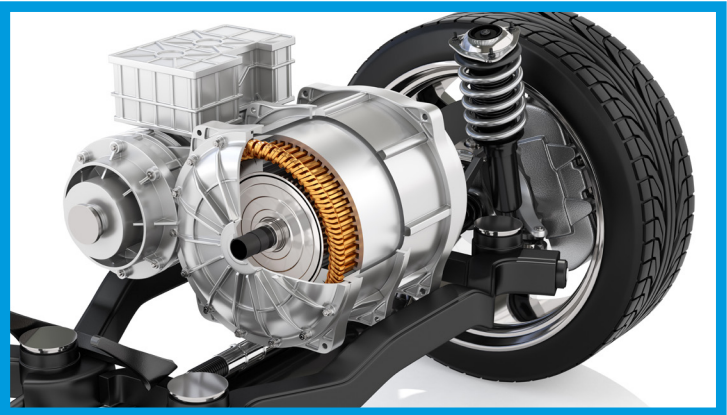


CHART 2: Breakdown strength measured in an epoxy resin system. Relative performances in other resin systems would be similar.



## HIGH-QUALITY SIGNAL TRANSMISSION

For high-speed data transmission and high-voltage, high frequency applications related to EVs, dielectric constant impacts the signal integrity and impedance. Lower Dk materials are preferred for high-speed signals to reduce losses, signal distortion, and minimize cross talk between closely spaced traces and vias.

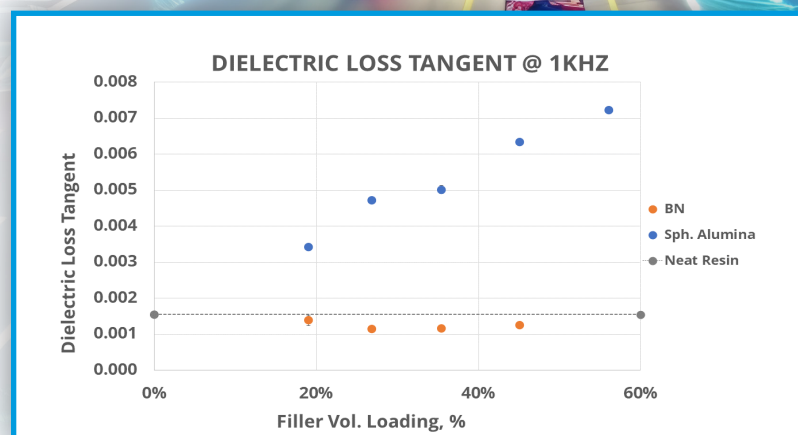
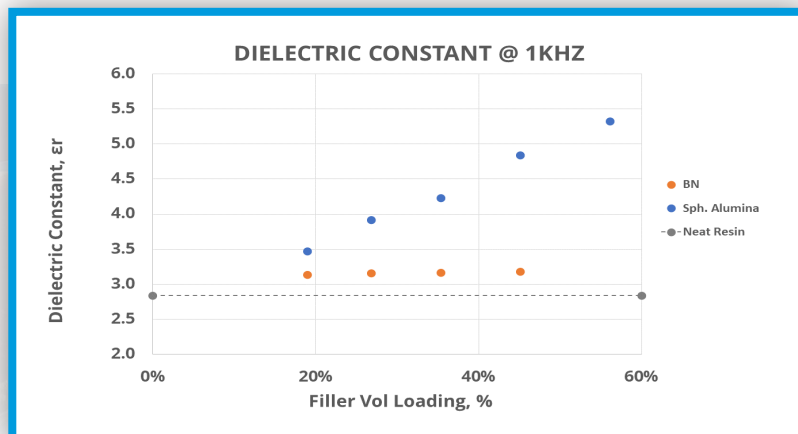
Boron Nitride has one of the lowest Dk of thermal fillers. Coupled with its very low dielectric loss properties, Df, Boron Nitride fillers enable low loss and excellent signal transmission/ low attenuation at high frequencies and for high voltage applications.

These combined properties of Boron Nitride make it a very attractive material for use in thermal management materials in power electronics, electric motors, battery assemblies, and high frequency signal processing components in EV applications.



## OUR EXPERTS ARE READY

Momentive Technologies is a leading supplier globally for high quality Boron Nitride products with a broad portfolio of more than 50 grades. Our MT Therm series of Boron Nitride powders are tailored to thermal management needs of EV applications. Our application development engineering team can provide detailed technical support to help customers select the best BN products for their specific requirements.



Dielectric properties measured in a silicone resin system. Relative performances in other resin systems would be similar.



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